Draft Statewide Maps and Modifications Report

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Standard	Standard review level.
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DOCUMENT HISTORY

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1.0 Background

The overall goal of this project is to improve the accuracy of wind resource estimates in promising areas of the State of California by addressing three key issues: the resolution of the original mesoscale and microscale model runs; the structure and modeling of the boundary layer; and measurements from tall towers and sodar. This report summarizes progress on Task 6: Adjustments to Statewide Wind Maps.

In Task 2 of the project, five promising areas of the state for wind energy development were selected for further study. The five areas are listed below:

Group	Description	County
B	Desert areas	San Bernardino
C	Surrounding San Gorgonio wind farms	Riverside
D	Surrounding Tehachapi wind farms	Los Angeles/Kern
H	Ridgeline sites	Sonoma/Lake/Napa
I	Northern valley site	Siskiyou

A map of the five focus areas overlaid on the California wind power map is shown in Figure 1.

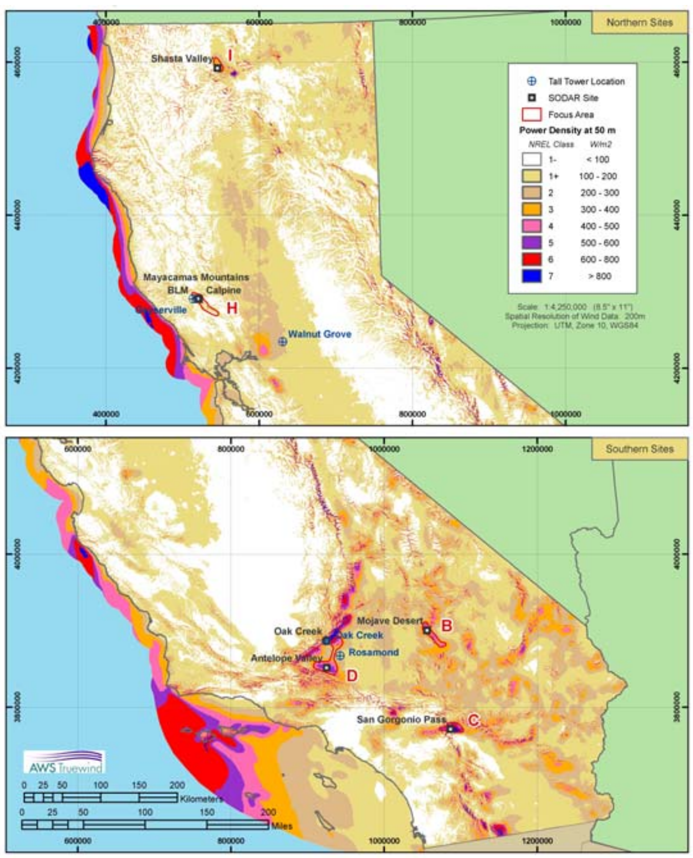

Figure 1: Map of the Five Focus overlaid on the California wind power map

In Task 3: Focus Area Mapping, the effect of model resolution on the wind resource in the five areas was investigated. Model resolution – expressed usually as the spacing between grid points in the simulations - affects how well the model can capture the influence of topography and variations in surface characteristics (such as roughness) on the wind resource. In the California wind passes, in particular, the mesoscale model, MASS, was suspected to be unable to fully resolve mountain blocking and channeling effects, which have a large influence on the wind resource both along ridgelines of the coastal mountains and in the main wind resource passes of the state. A secondary factor is the resolution of the microscale model, WindMap, which affects the degree of acceleration over small hills and ridges embedded within a larger flow pattern. In Task 3, the MASS grid spacing was halved from 2 km to 1 km, and the WindMap grid spacing halved to 100 m. The results, though difficult to interpret in some cases, generally followed expectations. In areas where mountain blocking and channeling are important, the higher mesoscale model resolution increased the blocking effect and produced stronger flows through the passes. In other areas, the high-resolution runs produce more sheltering of the valleys by mountain peaks. Katabatic flows out of the mountains into valleys in northern California appear to be moderately increased at high mesoscale resolution.

In the two regions – San Gorgonio Pass and Tehachapi Pass – where enough data was available to validate both the original and new maps, the high resolution runs produced a definite improvement in accuracy. The standard deviation between the map and observed wind speeds dropped in both cases by about 25%, while the degree of correlation (r^2) between the map and data increased from about 0.46 to 0.66. Since errors in the data contribute to the standard deviation, the actual improvement in map accuracy is probably greater than these figures suggest.

In Task 5, research was performed on a variety of modeling issues that could affect the accuracy of wind maps, including formulation of the boundary layer, using the non-hydrostatic pressure equations, alternative models, and alternative data bases used to specify soil moisture and sea-surface temperatures. A new formulation of the boundary layer called the “z-less” scheme, in which mixing is parameterized as a function of local shear and stability independent of height, was found to mitigate a tendency to overestimate nocturnal winds. The result was a modest decrease in the predicted mean wind speed in most areas. However running the MASS model in non-hydrostatic mode did not make a significant difference. Likewise there was little apparent difference in the performance of MASS and WRF (the new community mesoscale model being developed at the National Centers for Atmospheric Research). An improvement in simulation of winds through the San Gorgonio Pass was observed when the soil moisture content was increased to reflect current irrigation patterns. High-resolution sea-surface temperature data bases were identified, which should improve the accuracy of simulated land-sea circulations.

In Task 6, the results of the previous tasks were reviewed to determine what changes could and should be made to the statewide wind resource maps. This report describes the findings and conclusions.

2.0 Significant Findings

In Task 3, significant improvements were demonstrated in the accuracy of the high-resolution wind maps relative to the original maps in two areas: San Gorgonio Pass and Tehachapi Pass.

In San Gorgonio Pass, the changes resulting from the higher resolution simulations were quite similar to the manual adjustments made to the original maps during the validation. For this reason, no further adjustments were required in this area.

In Tehachapi Pass, the spatial pattern of changes resulting from the higher resolution simulations were quite different from the manual adjustments. Moreover the combination of the manual adjustments and higher resolution produced a more accurate map than either alone. It was concluded that it would be beneficial to incorporate the higher resolution Tehachapi map into the adjusted statewide wind map, especially considering that the Tehachapi area is likely to be a focus of wind energy development in the future.

In the other focus areas, not enough data was available to determine if higher resolution produced a significant improvement in accuracy. Furthermore, the pattern of changes in most of these areas was quite complicated and therefore difficult to apply on a statewide basis. Therefore, no adjustments were made to the statewide maps in these areas.

In Task 5, it was determined that the accuracy of the mesoscale simulations could be improved by implementing a “z-less” boundary layer formulation as well as a new soil moisture data base, which takes into account irrigation, and a new sea-surface temperature data base. However, it would not be possible to apply a systematic correction to the statewide wind resource maps to reflect these changes without running the mesoscale model, with the modifications, for the full sample of 366 days. The new map would then have to be validated again and possibly adjusted to address any remaining errors.

3.0 Conclusions

The higher resolution simulations in the Tehachapi area have been merged seamlessly into the statewide wind resource maps. The result, shown in Figure 2 and Figure 3, is a somewhat greater concentration of the wind resource in a narrower band south of the Tehachapi Pass and Cottonwood Pass. The changes elsewhere are modest.

Modifications to the wind resource maps in the rest of the state are not recommended at this stage. The improvements observed as a result of the z-less boundary layer formulation and new irrigation and sea-surface temperature data bases are generally moderate and would not produce a dramatic revision of the wind resource. Instead high-resolution mapping using the latest model formulation is recommend in the most promising wind resource areas.

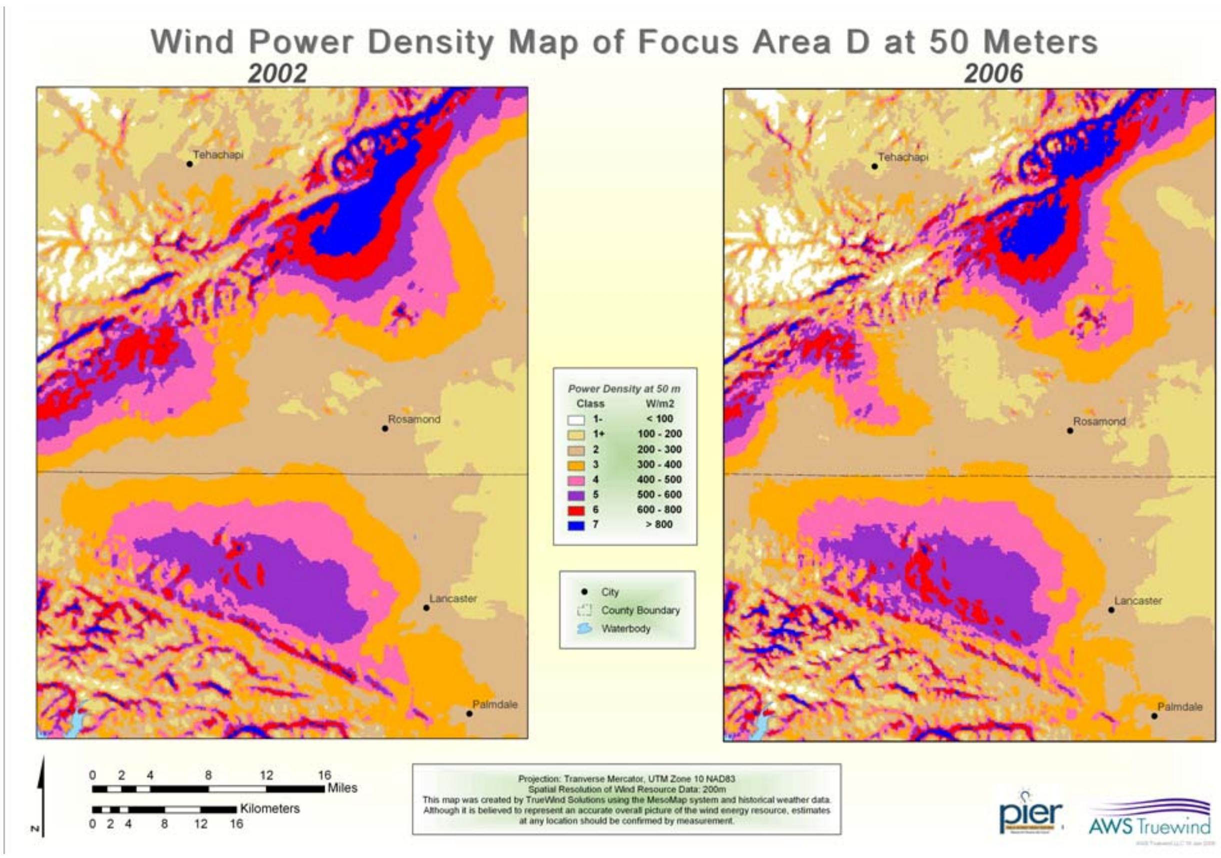

Figure 2: Comparison of 2002 and 2006 wind power density maps for Focus Area D

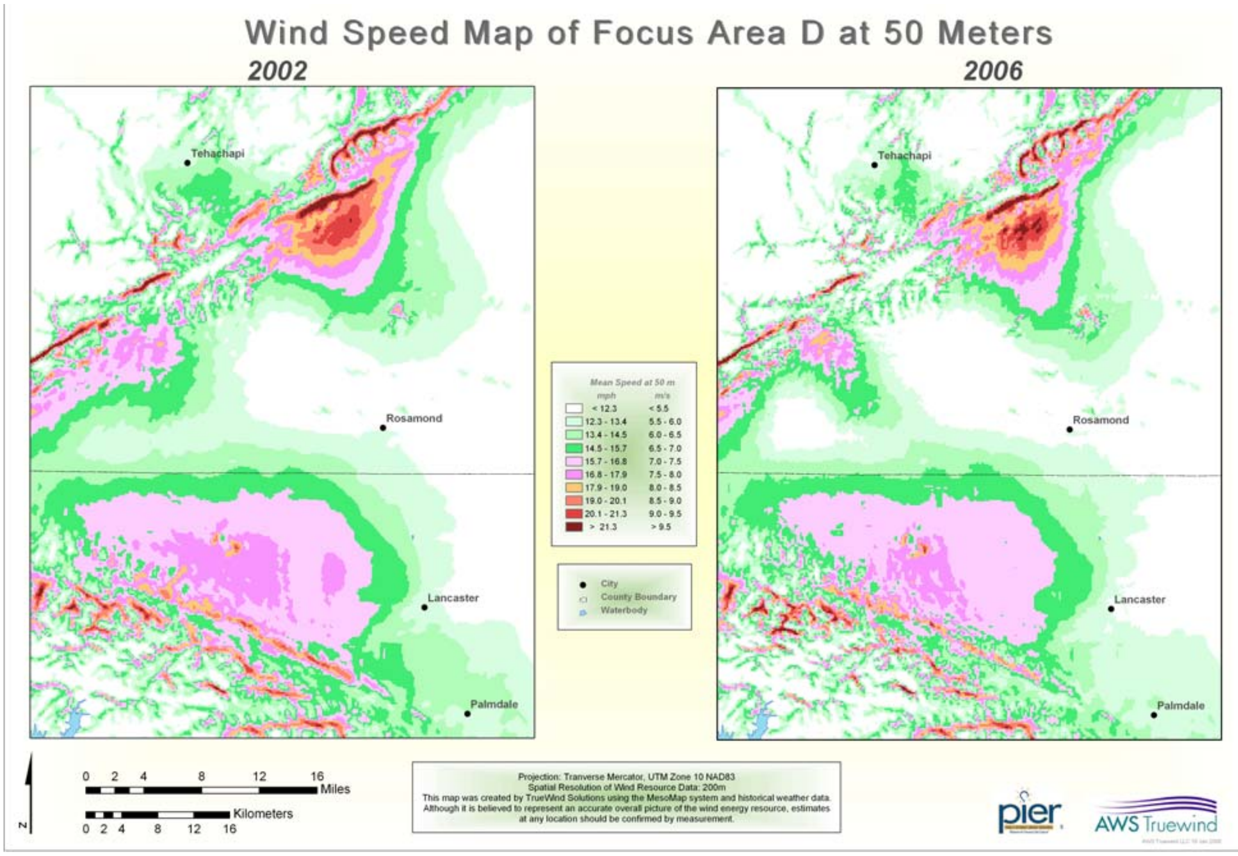

Figure 3: Comparison of 2002 and 2006 wind speed maps for Focus Area D